

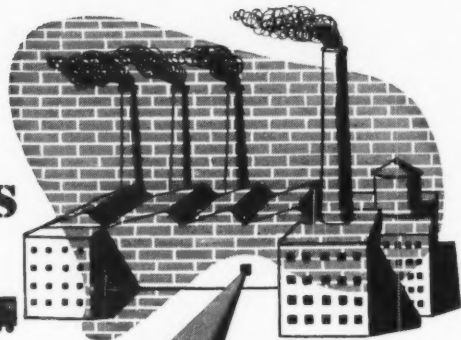
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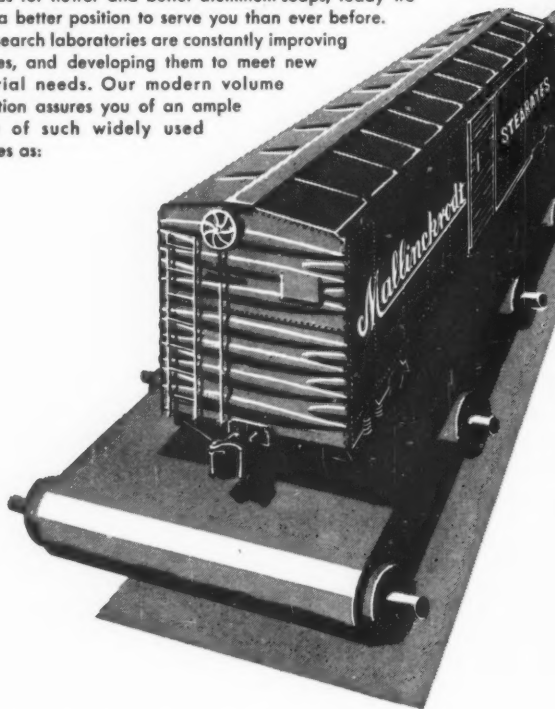
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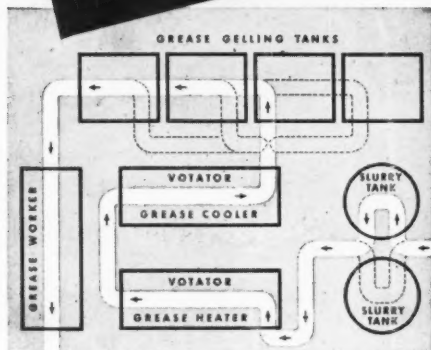
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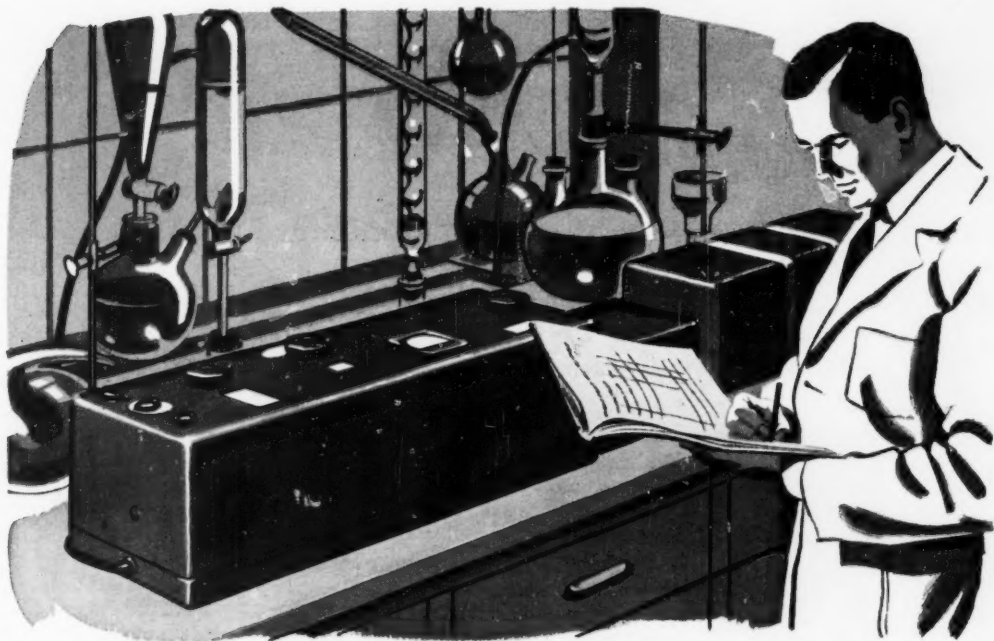
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President's page

W. Wayne Albright, President, NLGI

GREASE IS NOT JUST GREASE



"Oil is oil" is a phrase once commonly said about oil lubricants. Yet most people today realize that lubricating oils are highly specialized products specifically engineered for particular tasks. "Heavy duty" oils for cars is an example of this specialization.

Too many people today may still be saying, "Grease is grease." Those of us in the lubricating grease business are quite unhappy about this attitude on the part of people who should be more familiar with the role of modern grease lubricants. We know that grease products, perhaps even more than oils, are scientifically designed and expertly produced for highly specialized jobs. Successful grease lubrication encompasses many tasks from the simple to the extremely complex.

As a matter of fact, some of the most difficult lubricating jobs are best handled by specialized lubricating greases. Many complex requirements can be met only by using grease lubricants. Oils will not do the trick.

An example of a highly specialized grease lubricant, developed after extensive laboratory and field research, is an aircraft grease with a wide range of operating temperatures. Requirements for aircraft instrument bearings and control bearings may vary from extreme cold experienced at high altitudes to the extreme heat developed in parts located near jet engines. Greases have been developed that provide effective lubrication at temperatures as low as -100°F . and as high as 300°F .

In many lubricant applications we can see an increasing trend toward designing equipment for grease rather than oil lubrication. Anti-friction bearings in electric motors used in so many of our modern household appliances such as refrigerators, mixers, vacuum cleaners and portable tools are now lubricated with a sealed-in-for-life grease product. This has been made possible because better greases were developed by grease manufacturers. In modern production machinery, where oils were formerly used, we see the same switch to greases—again because of the better specialized greases now available.

This development would not be possible if it were not for the special qualities we have been able to build into modern lubricating greases—qualities that are the result of highly developed technology and scientific approach.

NLGI activities have played and continue to play a large part in bringing about the improvement in lubricating greases. It is the responsibility of all of us in the industry to tell the lubricating grease story to help users and the lay public to better understand the high level of achievement represented by the fine products of our industry.

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The INSTITUTE Spokesman

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ABOUT THE COVER

Our cover page this month finds our artist, Jim Cunningham, catching the spirit of the Rubin and Mosteller article, "USAF Grease Development and Lubrication Problems." The entire work is designed around the lubricant problem encountered by modern military aviation whose electronic and other equipment calls for operation at ambient ranges of -85 degrees Fahrenheit to +400 degrees Fahrenheit.

Past cover pages have usually been photographs illustrating equipment or products furnished by our associate members. Since there was no cover page sponsor for this month, we thought we'd try our hand at creating a design. Here we're trying to give the impression of a jet plane traveling from extreme heat to extreme cold, leaving the demands it's making on lubricants and the men who designed them to your imagination.

FOAMING



FIGURE 1 — Special Mixmaster Blades.

FOAMING of gear oils and certain industrial oils is occasionally encountered in service. In most cases it is harmless, but because of the pronounced change in the appearance of the lubricant, especially the lighter colored oils, frequently it leads to complaints.

The cause of foaming is a rather specialized and complex study. Furthermore, relatively little work has been done on laboratory methods for evaluating the foaming tendencies of gear and industrial oils. Because ASTM designation D892-46T, "Foaming Characteristics of Crankcase Oils" is specifically limited in scope to *crankcase oils at specified temperatures*, obviously it may not apply to the foaming of *gear oils at other temperatures*. As originally developed to solve a specific problem during World War II, major objectives of this method were to determine foaming tendency, foam stability, and the *permanence of the foam inhibitor* in dry sump engines where the excess scavenging pump capacity resulted in extreme aeration of the oil.

In this test a very viscous oil without foam inhibitor normally shows heavy foaming at low temperatures. In a gear case, however, such an oil may show relatively little foaming at low temperatures, considerable foaming at some higher critical temperature, and little or no foaming at still higher temperatures.

Observation of an open gear case with slowly turning gears gives some clues as to what is happening to the oil. At low temperatures, when the oil is quite viscous, so much lubricant adheres to the gears that the teeth are well covered; each gear may resemble a rotating disc or cylinder of oil. Since the teeth are not well defined, apparently not much air is pulled into the lubricant by the dipping teeth.

As the lubricant is heated, and becomes less viscous, the exposed teeth are coated with thinner oil films and, being better defined, apparently pull more air into the oil. However, the oil is still so viscous that the bubbles do not break up readily.

At still higher temperatures, while the rate of air inclusion may still remain high, the reduced viscosity of the oil prevents an accumulation of bubbles.

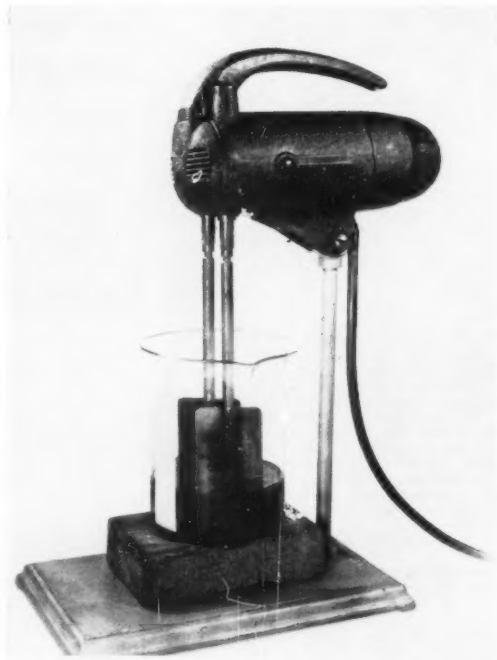


FIGURE 2a — Oil Before Whipping.

OF HEAVY OILS

by Robert G. Moyer
The Pure Oil Company
Research and Development Laboratories
Crystal Lake, Illinois

These observations of foaming tendencies indicate that in gear cases the factors affecting accumulation of foam include the mechanical beating action peculiar to gear teeth and similar parts, and viscosity or temperature of the lubricant. Complete evaluation of these factors is not possible by means of ASTM D892-46T (There are, of course, other items which influence foaming such as the presence of detergents, the type of oil stock, the presence of moisture or volatile components, etc.)

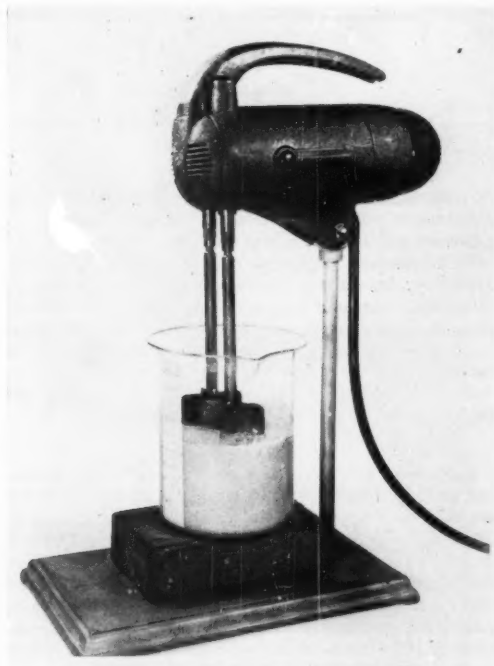


FIGURE 2b — Oil After Whipping.

In order to obtain a better understanding of the foaming of heavy oils which do not contain foam depressants, a laboratory study was made to determine the relationship between foaming tendency and temperature in an apparatus having a beating action not unlike a gear train.

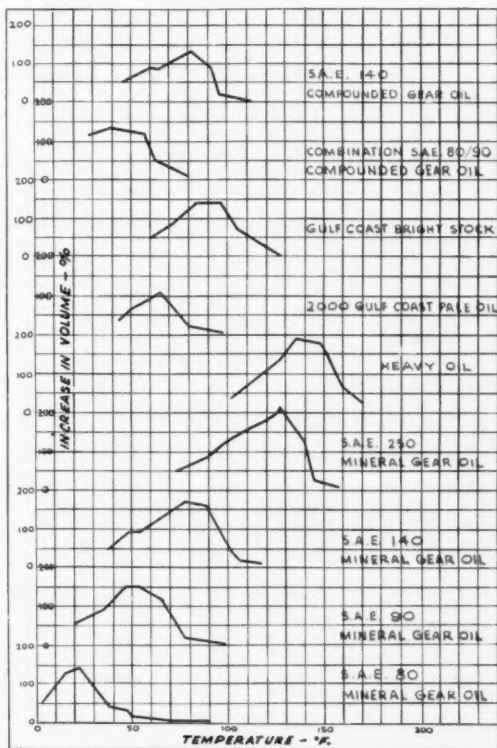


FIGURE 3

FIGURE 4

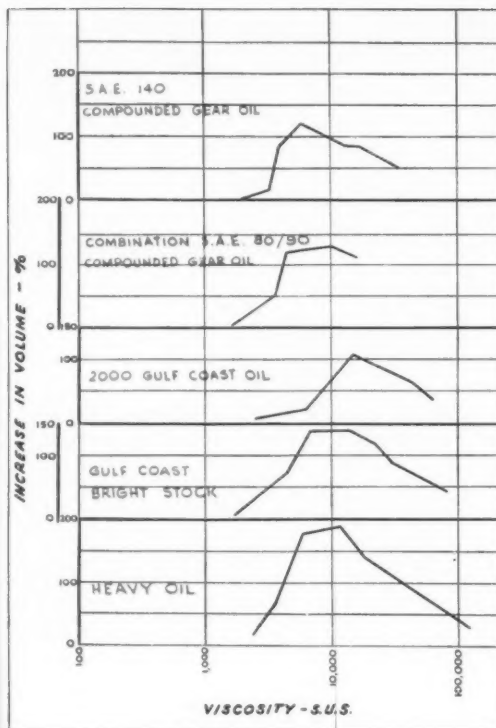
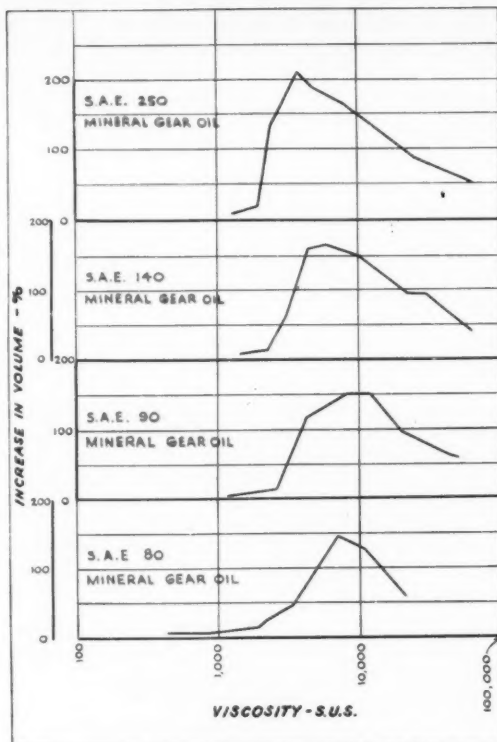


TABLE I

Test Oil	Viscosity at 100° F. S.U.S.	Viscosity at 210° F. S.U.S.	V.I.
SAE 80 Mineral Gear Oil	373.1	56.0	93.9
SAE 90 Mineral Gear Oil	1173.9	95.2	93.6
SAE 140 Mineral Gear Oil	2986	163.6	90.2
SAE 250 Mineral Gear Oil	15640	291	36.7
Heavy Oil	16620*	571	-86
Gulf Coastal Bright Stock	5936	136.1	-34
2000 Gulf Coast Pale Oil	2158	83.5	-39
Combination SAE 80/90 Compounded Gear Oil	858	86.4	106
SAE 140 Compounded Gear Oil	2970	162	92

*Viscosity at 130° F.

FIGURE 5



A simple mechanical test procedure was established using a Mixmaster with special blades as shown in Figure 1. A graduated one liter beaker was filled with the test oil to the 300 c.c. mark and whipped for five minutes at approximately 380 RPM. Immediately after whipping a reading was taken of the total volume of aerated oil and this was converted to per cent increase in volume. A temperature control cabinet was used as necessary to maintain test temperatures. A variety of oils including compounded gear oils as well as straight mineral oils was tested under these conditions and Figures 2a and 2b illustrate a typical foaming oil.

Each of the test oils was whipped at several temperatures and a critical temperature was found for each oil at which the increase in volume due to foaming was greater than at either higher or lower temperatures. As shown in Figure 3 the critical temperature was not the same for all oils. When the viscosity at test temperature was determined from the viscosity-temperature curves and plotted against increase in volume due to foaming, the curves of Figures 4 and 5 were obtained. Apparently a critical viscosity range exists, which is the same for all of the test oils, at which foaming is greater than at either higher or lower viscosities.

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Titre	134.6° min.	
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Unsaponifiable	0.25% —	0.75%
Saponification Value	202	— 204
Acid Value	201	— 203
Iodine Value (WIJS)	3 max.	—



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FIGURE 6

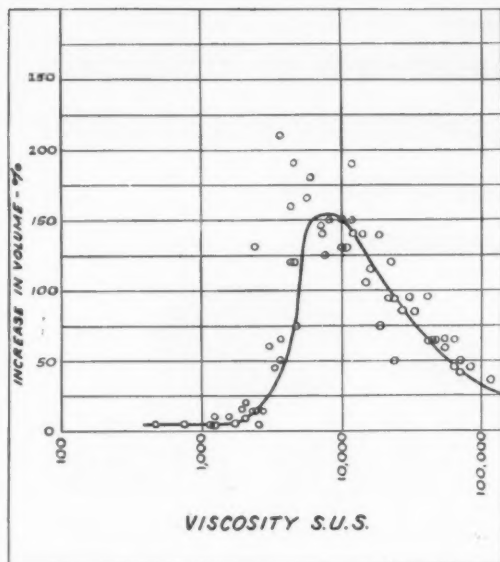


Figure 6 is a composite of all of the test data representing about seventy determinations: the curve was drawn arbitrarily through the points and does not represent a statistical analysis. A trend is obvious and indicates a critical viscosity range between approximately 4000 and 20,000 Saybolt seconds. It will be noted from Table I that the test oils represent a wide range of viscosity indices and include Gulf Coastal conventional-refined as well as Mid-Continent solvent-refined oils.

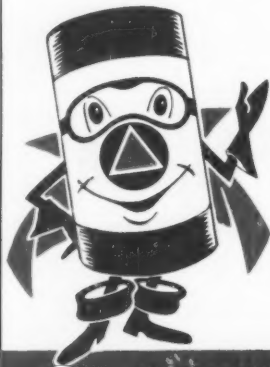
From the above it should not be concluded that all oils will foam in the critical viscosity range. The addition of minute quantities of foam depressants to the test oils effectively prevented any formation of foam. No appreciable foaming tendency was observed with a synthetic oil (UCON LB 1200X). On the other hand, if an oil has a tendency to foam the operating viscosity appears to be an important factor.

The application of this information to actual service has resulted in the solution of most heavy oil foaming complaints in gear cases. From Figure 3, for example, it is obvious that the SAE 140 oil operating at 90° F. will accumulate considerable foam. However, a change to the SAE 90 grade will almost completely eliminate foaming at this temperature. In automotive service, many foaming difficulties have been traced to observations made during the "warm up" period. After the lubricant has reached operating temperature—i.e., is out of the critical viscosity range—foaming usually is almost completely eliminated.

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USAF GREASE DEVELOPMENT AND LUBRICATION PROBLEMS

Bernard Rubin and J. C. Mosteller
Wright Air Development Center
Wright-Patterson Air Force Base, Ohio

ELECTRICAL AND ELECTRONIC EQUIPMENT in abundance are carried in the nose section of an aircraft as shown in this model, displayed in the Wright Air Development Center's components and systems laboratory.



Abstract

As military aircraft fly at higher and higher altitudes, lubricants which will function satisfactorily at the extremely low temperatures encountered are more and more important. These same lubricants, however, must also function satisfactorily at the very highest ground temperatures and in certain types of equipment which are so compact that very high temperatures are developed in normal operation.

Investigation of the USAF to satisfy the need for an extreme low temperature grease has led to the commercial development of a diester type grease described by the recently issued Specification MIL-G-7421 (USAF). This grease is currently being used in several applications where operating problems in the -65°F . to -100°F . have been encountered.

Development of high temperature greases for operation in the 400°F . to 500°F . range has been making great strides forward. Thickening agents such as the copper phthalocyanines and other nitrogen compounds are stable at the high temperatures and are available commercially or not difficult to prepare at reasonable cost. The greatest shortcoming today, hampering the full exploitation of these new thickening agents, is the lack of suitable very wide range oils (-100°F . to 500°F .) and oils for extremely high temperature greases.

Several special lubrication problems have been successfully answered. Silicone-diester oil blend lithium soap greases appear to have solved the rubber-to-metal lubrication problems of pneumatic system components. Lubricants for ground equipment handling strong oxidizing acids have been developed. Lubrication of high-speed instruments, however, poses a problem requiring careful definition of variables.

Introduction

In a paper presented to the National Lubricating Grease Institute in October, 1950, progress in the development and use of synthetic grease was discussed. The paper noted that several problems remained yet to be solved. This paper will attempt to present the state of the art with respect to a solution to these problems and introduce some new ones. Aircraft design presents a never-ending challenge to the materials engineer.

Low Temperature Lubricants

The need for a grease with better low temperature properties than can be obtained with the materials supplied under Specification MIL-G-3278 has been definitely established for equipment located in the air stream at high altitudes and for equipment with very low starting torque required by specification to operate at -65°F . or lower. Typical devices fitting into these categories are small actuators, flea-horsepower electric motors, flight control mechanism of certain aircraft, and electronic controls.

Preliminary study (Ref. 1) revealed that two classes of commercially available oils had the viscosity-temperature relationship suitable for a -100°F . to 250°F . grease. These were the silicones and the diesters. The excellent low temperature possibilities of blends of these two oils had also previously been indicated (Ref. 2). The best silicone-



A WING SECTION is prepared for a maximum lift test in the 20-foot subsonic wind tunnel. Speeds up to 450 mi's per hour can be reached in this facility.

diester greases were superior in low temperature performance to the diester greases. Unfortunately, poor lubricity prevented their adoption as an extreme low temperature grease. As a result, effort was concentrated on diester formulations to establish target requirement limitations. In January, 1950, a specification was prepared and circulated to the grease manufacturers with a request that samples conforming as closely as possible to the target requirements be forwarded to the Materials Laboratory for evaluation. The target requirements are tabulated in Table I.

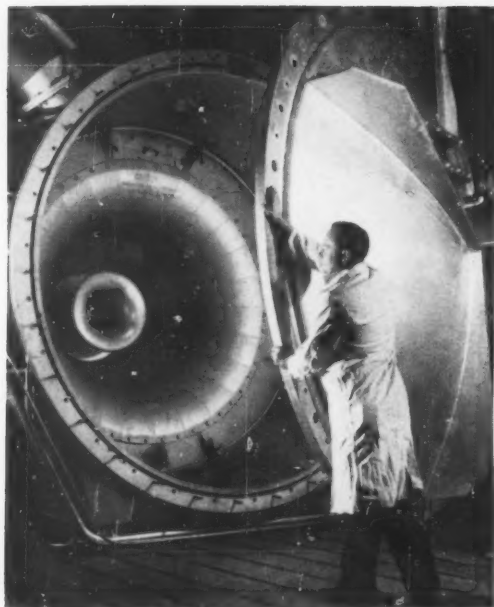
Table II compares the data of several samples against the low and high temperature requirements of the original proposed specification.

It became quickly apparent from this data that the diester type greases as supplied by industry would not meet all the high and low temperature requirements and a revision to the proposed limits was in order. Further evaluation of additional samples provided one grease from a major grease manufacturer which had the properties shown in Table III.

As a result of these evaluation tests, four changes were made in the target requirements noted in Table I. Comparison of Table I and Table III will show the revisions in the oil separation, evaporation, high temperature performance and apparent viscosity. In February, 1952, Specification MIL-G-7421 (USAF), "Grease Extreme Low Temperature" was issued by the Air Force for procurement purposes.

Experience as to the practical limitations of the currently available material is noted below.

Investigation of the endurance life of this grease is an aircraft actuator indicates that the life expectancy of the material is less than that of the MIL-G-3278 grease. Tests on a Lear Inc., Model 420 actuator (steel nut and bronze screw



A TANK TYPE TEST CELL simulates high altitude for development testing of gas turbine engines.

+28 V.D.C.) loaded to the maximum design load of 1800 pounds on a one minute on, two minutes off cycle (room temperature ambient) provided data as follows:

Grease E (Conforming to Spec MIL-G-7421)

Gears — Grease and gears satisfactory after 5000 cycles.

Screw — Grease dried out after 1500 cycles.

Grease — (Conforming to Spec MIL-G-3278)

Gears — Grease and gears in good condition after 5000 cycles.

Screw — Grease and gears in good condition after 5000 cycles.

Intensive testing of the new specification grease was conducted in the flap drive system of one of our bombers. Due to inherent system design characteristics, operation of the system at -65°F. as unsatisfactory with Specification MIL-G-3278 grease as a lubricant. However, the breakaway and running power of the motors when lubricated with Specification MIL-G-7421 (USAF) grease was within the torque requirements of the flap drive system (at -65°F.). This saved many thousands of dollars in immediate redesign cost and reduced the time required for production and for operational use.

Several devices having extremely small starting and running torque have successfully started at -80°F. and completed endurance tests when lubricated with the MIL-G-7421 (USAF) grease. This grease, therefore, satisfied the requirements of many of the equipment manufacturers for

TABLE I
PROPOSED LIMITS FOR
EXTREME LOW TEMPERATURE GREASE

TEST	PROPOSED LIMIT	METHOD NO. IN SPEC.
		VV-L-791d
Penetration ASTM	Between 260-300 (worked)	31.1
Dropping Point	325°F. minimum	142.1
Apparent Viscosity	10000 poises max. at -100°F.	30.6
Bomb Oxidation	Max. drop of 5 psi in 100 hrs.	345.3
Low Temperature Torque	Not more than 5 secs. at -100°F.	—*
Evaporation	5% maximum loss in 22 hrs.	35.1
Oil Separation	8% maximum loss in 30 hrs.	32.1
High Temp. Per- formance	1000 hrs. at 1000 rpm and 250°F.	33.1
Gear Wear	2.5 mg. per 1000 cycles—5 lb. load 3.5 mg. per 100 cycles —10 lb. load	—*
Copper Corrosion	No pitting, etching, slight stain permis- sible	530.3
Worked Stability	Max. Penetration of 375	31.3

*For procedure see Specification MIL-G-3278

a grease with better low temperature properties than the general purpose synthetic, MIL-G-3278. Data obtained on an actuator driven by 0.01 horsepower, 400 cycle — 115 volt A. C. motor is presented in Table IV.

The authors wish to emphatically assert that the new extreme temperature grease does not replace MIL-G-3278 for general purpose use. Spec. MIL-G-7421 is intended for use in those applications where, with proper design, problems of starting exist at -65°F. or lower. Its upper temperature limit for continuous use in sealed bearings or bearings where 1000 hours of operation is needed is approximately 225°F. to -235°F.

The MIL-G-7421 grease will operate for a considerable length of time at 235°F. to 260°F. level, but a decrease in equipment performance should be expected over that obtained with MIL-G-3278 at this price range. The high temperature endurance test time for the general purpose synthetic grease is approximately 2000 hours compared to the 725 hours obtained with the new grease. This is not an entirely unexpected result, however, as the evaporation of Grease E is four times as great after 100 hours at 250°F. as the MIL-G-3278 made by the same manufacturer.

TABLE II

TEST DATA ON EXPERIMENTAL EXTREME LOW TEMPERATURE GREASES

Test	Pro-posed Limit	Grease			
		A	B	C	D
Bleeding — %	8	2.9	3.5	0.8	0.9
Evaporation—%	5	0.3	—	4.6	3.4
High Temp. Endurance—hours	1000 hrs.	505	400	829	1937
Low Temp. Torque	5 sec.	2.4	Pass	6.2	10.2
Apparent Viscosity	10000 poises	19000	8900	Too viscous to run	Too viscous to run
Materials Laboratory Code No.		4480	4591	5258	5259

The High Temperature Problem

The high temperature lubrication problem has been fully described earlier (Ref. 1). However, to briefly recapitulate: Air Force requirements for electronic equipment in current design calls for operation at ambient ranges of -85°F. to $+400^{\circ}\text{F.}$ If an operating temperature rise is allowed in this equipment, running temperatures of 450°F. may not be uncommon. Aerodynamic heating of presently designed high speed aircraft and missiles can lead to skin temperatures of 400° to 450°F. , throwing a high radiation heat load on equipment, such as the jet combustion and exhaust section which also increases the temperature of aircraft components. Use of high temperature air bled from the compressor section also causes high temperatures in certain equipment. It is not possible to go into details on most of these applications because of security considerations, but the general statement above covers a multitude of equipment. Where the high temperature requirement is current for operational equipment, short life, high maintenance cost and questionable reliability at low temperatures necessarily have been the penalty.

To provide for a grease suitable for several hundred hours in the 400° to 450°F. range (and approaching as close as possible to -65°F.) the Air Force contracted with the Standard Oil Company (Indiana) for the necessary research and development.

Development has been confined to the formulation of greases in the non-soap thickening agents, inorganic and organic, with the best available high temperature oil, a silicone oil with the following properties:

Flash Point	600°F.
Pour Point	-50°F.
Viscosity	
100° F.	20cs
210° F.	95cs

TABLE III

TEST DATA ON EXTREME LOW TEMPERATURE GREASES AGAINST REVISED REQUIREMENTS

Test	Specification MIL-G-7421 (USAF) Requirement	Grease E
Bleeding — %	5% max. in 30 hours.	4.2
Evaporation — %	2% max. in 22 hours	0.8
High. Temp. Endurance	650 hours at 250°F. and 10000 rpm	726
Low Temp. Torque	5 seconds max. at -100°F.	4.4
Apparent Viscosity	15000 poises at -100°F.	13000
Materials Laboratory Code No.		4728

TABLE IV

ACTUATOR STARTING AND RUNNING TORQUE TEST

Grease	Room Temperature Performance*		—100° F. Performance*			
	Extension	Retraction	No load	30 lb. load	Ext.	Ret. Lifting Helping
A	4.1 sec.	4.1 sec.	5.9 sec.	4.6 sec.	5.5 sec.	4.3 sec.
C	"	"	11.2	20.5	—	—
D	"	"	Inoperative			
E	"	"	4.3	4.2	4.3	3.9

Actuator

20-hour soak at test temperature using light film of lubricant.

*Average value of four units

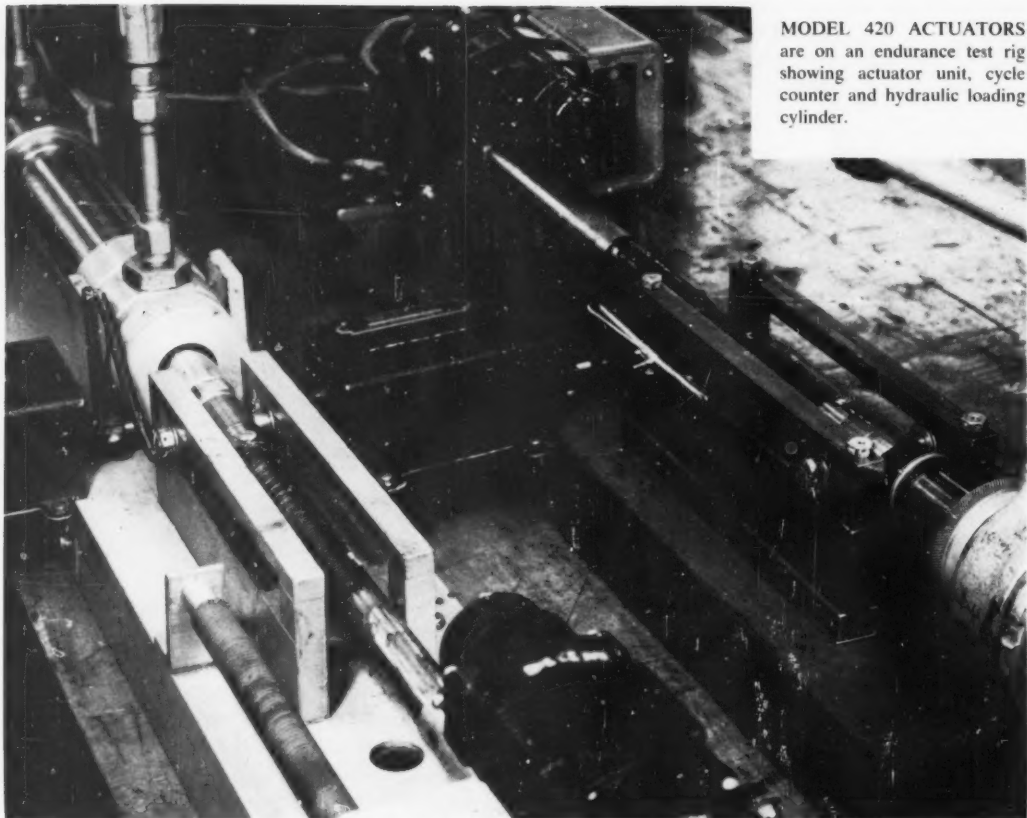
Grease E = Materials Laboratory MLG-4728

TABLE V

ENDURANCE LIFE OF HIGH TEMPERATURE GREASES

Grease with Silicone Oil	Endurance Time in Hours at 450°F.
Commercial Soap Grease A	145
Commercial Soap Grease B	175
Copper Phthalocyanine	300-360
Polymers (Several types)	5-30
Calcium Acetate and Stearic Acid	335
Nitrogen-Containing compounds:*	
Compound A	188
Compound B	255
Compound C	650

*Phthalocyanine grouping not present in these compounds.



MODEL 420 ACTUATORS are on an endurance test rig showing actuator unit, cycle counter and hydraulic loading cylinder.

A number of requirements were established but the most severe, from a high temperature viewpoint, was that requiring satisfactory lubrication of a bearing for 500 hours in the high temperature bearing tester at 450° F. Satisfaction of this requirement with a non-corrosive and mechanically stable grease has represented the bulk of work on this contract to date.

The following represents typical data in the bearing endurance tests at 450° F. with inorganic thickeners.

Inorganic	Hours to Failure
10% Silica gel	103
25% Silica gel	9
20% Asbestos	16
30% Boron nitride	10
15% Carbon Black + ¼% Teflon	85

Various other materials such as vermiculite, treated clays,

metal oxides, molybdenum disulfide and metal particles of colloidal size dispersed in oil yielded greases with an endurance life of two to fifty hours.

Many attempts were made to improve the performance of the inorganic thickening agent-oil system. Control of particle size, chemical treatment to remove possible impurities and addition of a third component to the gel system were tried without success. Hydroxy compounds, polymers, esters, amines, organic acids, silicates and borates were used to improve the properties of the silica gel-silicone oil system. In no case, for any of the formulations in which an apparently stable grease-like structure was achieved, did the life endurance exceed that of the simple two-component systems. The failure of the silica gel-silicone oil appears to be due to lack of mechanical stability while being worked at the high temperatures. X-ray data indicate attrition of the silica gel particles of extremely small size may be a primary cause of the mechanical instability.

The organic thickening agent-oil system has proved a much more fruitful field of investigation. The investigations of the Naval Research Laboratory into the greases made

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* Courtesy Warren Refining and Chemical Co.



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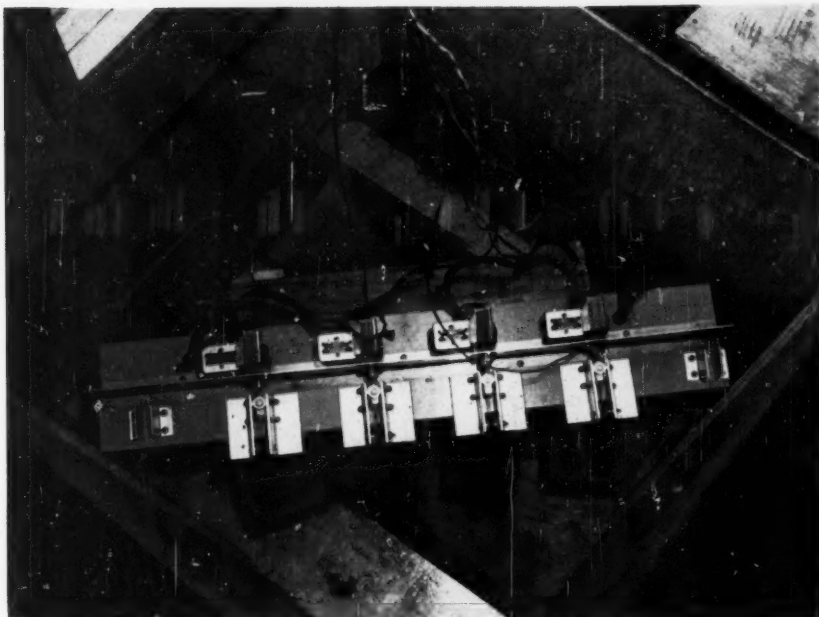
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SMALL ACTUATORS
in Aminco cold box are
shown just prior to full
load tests at -100° F.



from copper phthalocyanine were reported to the NLGI last year. Bearing endurance test data on commercial and experimental greases containing organic thickeners are noted below. The test is run at 10,000 rpm under light radial and thrust load.

It is to be noted that grease made with Compound C exceeds the 500-hour requirement by a considerable margin and is in addition mechanically stable and non-corrosive to steel and copper. These materials are being developed further.

Finally, it is well to note the anomalous behavior of the non-soap-silicone oil greases with respect to evaporation loss. The evaporation rate of the oil at elevated temperatures is greater from the finished grease than from the oil alone.

Special Lubrication Problems

Lubricants and Pneumatic Components

The materials previously reported (Ref. 3) proved to be inadequate in service in two respects. Units such as solenoid valves would not function below -50° F., and actuating cylinders and other units were sluggish at -65° F. Furthermore, the rust preventive qualities were very poor.

Earlier investigation (Ref. 2) had shown that greases with excellent low temperature properties could be made by silicone-diester oil blends thickened with lithium soaps. The basic lubrication problem for these components was to provide a grease which would not adversely affect the rubber. A maximum swell of 10% may be tolerated in the finished Buna rubber articles.

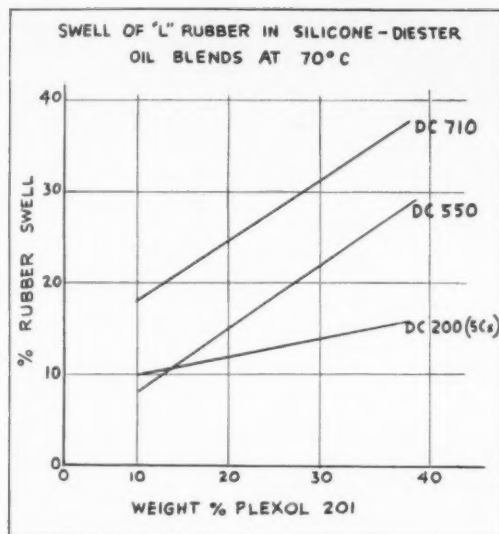
Silicone oil will shrink the Buna rubber and the diester oil will swell it excessively. However, the data presented graphically show that such mixtures may be adjusted to control the swell to any desired level. The data was obtained on an unplasticized "L" (Buna N) stock. (See graph on following page.) A 17% to 30% swell of the unplasticized stock is roughly equivalent to 0-10% swell of the finished rubber. A maximum swell is reached in 144 hours under the tests' conditions (Ref. 4). The time-swell relation with varying percentages of plexol 201 in DC-550 is shown in Table VI.

TABLE VI
SWELL OF "L" STOCK IN PLEXOL-201 & DC550
OIL BLENDS AT 70° C.

Time-Hrs.	Volume Swell-Percent			
	10% Plexol 201	20% Plexol 201	30% Plexol 201	40% Plexol 201
24	5.6	10.4	16.0	21.5
48	6.9	12.9	19.3	26.9
72	7.6	13.9	20.4	28.2
144	8.5	14.8	21.0	28.8
312	8.5	14.9	21.1	29.2

DC-550-Silicone Oil

Plexol 201-Commercial
Diester Fluid



Greases were prepared with the following materials (on a weight basis).

Soap	14%
75% Lithium Stearate	
25% Lithium Hydroxystearate	
Oil	84.5%
70% DC-550	
30% Plexol 201	
Oxidation Inhibitor	0.5%
Paranox 441 or	
Phenothiazine	

The greases passed most of the requirements of MIL-G-4343. The greases had a worked penetration of 240 and an apparent viscosity of 15,500 poises at 20 reciprocal seconds at -65° F. Although no further formulation studies were carried on, it was apparent that by variation of the soap ratio and percentage in the finished grease and the choice of an oil other than DC-550 the 260 ASTM worked penetration and 5000 poises apparent viscosity requirements could be met. A grease is available today from a commercial source which will meet all the requirements of MIL-G-4343.

Pneumatic system design is being directed toward operation with source air pressures of 3000 to 5000 psi. Investigation of the performance of pneumatic system greases at the higher pressures indicates that with an actuating cylinder at room temperature the grease is satisfactory at 3000 psi.

Finally, it should be noted that the converse approach of fitting the rubber to a standard synthetic grease has been investigated and successful rubber recipes have been developed. Such a rubber is described by specification MIL-R-7362.

TABLE VII
**ENDURANCE LIFE OF GYROS WITH
SEVERAL GREASES**

Grease	Type	Time to Failure— Hours
#1	Proprietary	2888, 3477
#2	Spec MIL-G-3278	726, 1386
#3	Spec MIL-G-3278	1600, 1659
#4	Spec MIL-G-3278	2363, 1600
#5	Spec AN-G-25	1320

This should be satisfactory where contact with diester type greases and oils is a problem.

Lubricants for use with Fuming Nitric Acid

The introduction of the modern rocket motor in aircraft and missiles has created a need for lubricants stable in the presence of powerful oxidizing agents. A lubricant stable in the presence of fuming nitric acid, dilute acid and water, and shock and impact insensitive in the fuming nitric acid has recently been developed and should be applicable to lubrication of accessory equipment of rocket motors and ground equipment handling strong oxidizers. This material is proposed for use in two grades to cover the ambient temperature range of -65° F. to 160° F. A single grease for the temperature range is desired.

Instrument Lubrication

The use of electric gyro instrument elements contained in a highly evacuated and hermetically sealed case appears to have produced a serious lubrication problem. (See Table VII.) The high temperatures imposed upon the case during the evacuation and degasification process are probably one source of trouble. Increased operating temperatures are being employed, and the Air Force and instrument manufacturers are anxious to increase the overhaul time of instruments from 1000-1500 hours to 3000 hours. This would increase reliability, reduce maintenance and reduce the inventory of expensive equipment. Part of the problem lies with design, but better specification lubricants can undoubtedly aid in increasing life.

One manufacturer has presented the following data on performance of a gyro at an ambient temperature of 160° F. (See Table VII.) Failure was determined by the decrease in free coast time and increase in bearing temperature. Much work remains to be done to arrive at complete understanding of the basic lubrication problems involved.

Packaging and Preservation of Bearings

In a previous paper (Ref. 3) failure of packages used for bearings prelubricated with the specification diester greases was reported. Investigations of the Forest Products Laboratory, under contract to the Air Force, has revealed materials which provide excellent intimate wrappers and moisture-vapor barriers for packaging the prelubricated bearings in a flexible package. Excellent results have been obtained, thus

far, in the packaging of bearings in cans completely filled with a preservative compound, operational grease or rust inhibited oil.

Future Requirements and Trends

Our research and development must perforce, be keyed to the requirements of the airborne weapon system. Thus, the drawing board designs and components which have advanced to the mock-up stage have provided a requirement for both a wide operating temperature range and operations at great extremes in high and low temperature. Our basic philosophy has been to attempt to answer all design needs with as few materials as possible, utilizing materials which are reasonable in cost in terms of the over-all cost of the equipment being lubricated.

Up to 1949 the number of lubricants required to service Air Force equipment was continually being reduced. However, with the continually widening temperature range requirements for lubricants and the introduction of synthetic lubricants to satisfy these needs, the number of lubricants has increased. This increase in number of lubricants may continue until the tempo at which the temperature limits are being widened slackens or until a plateau in the temperature curve is reached. It is to be hoped that by that time, if not sooner, development of new wide range oils and greases will have reached a point where decrease in the number of lubricants will be possible again.

The development of these new lubricants, at the present, hinges upon the availability of fluids that remain liquid over

wide temperature ranges. The Materials Laboratory is engaged in a vigorous research and development program to produce fluids suitable for lubricants. This includes the following: various types of esters; halogenated materials such as fluorinated esters, ethers, and fluorinated hydrocarbons; silicones and silicates; organic-phosphorous-silicon compounds; polynuclear compounds; and organometallic materials. Study is also being directed toward new and improved high temperature oxidation inhibitors. Recent developments indicate that materials which remain liquids over extremely wide temperature ranges and which have good lubricity can be made in the laboratory. The future of these materials is dependent upon their susceptibility to improvement of properties such as hydrolytic stability and oxidation stability.

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Technical Committee

Chairman T. G. Roehner, Director of the Technical Service Department, Socony-Vacuum Laboratories

N. Marusov, of Gulf Research and Development Company, has replaced L. C. Brunstrum, of the Standard Oil Company (Indiana), as chairman of the Subcommittee on Delivery Characteristics of Dispensing Equipment for Lubricating Greases. It will be recalled that this subcommittee's project involves the formulation of means for expressing the delivery characteristics of chassis grease guns in terms of physical characteristics of the lubricating greases they will handle at specified rates of delivery. The subcommittee's work has shown that consideration must be given to both slumpability, namely, the rate of priming of the gun, and to pumpability, the rate of flow of the grease from the gun. So far as pumpability is concerned, the data obtained to date indicate that apparent viscosity is a satisfactory means for indicating that property. The slumpability factors are currently under investigation.

The subcommittee with Mr. Brunstrum as chairman has made remarkable progress in view of the complexity of the project. There is good reason to predict that the following organization will find the remaining answers required to complete the assignment.

N. Marusov (Chairman), Gulf Research & Development Company

L. C. Brunstrum, Standard Oil Company (Indiana)

E. S. Carmichael, Socony-Vacuum Oil Co., Inc.
J. F. Carter, Aro Equipment Corporation
E. W. Cave, Continental Oil Company
R. P. Field, Balcrank, Inc.
N. J. Gothard, Sinclair Refining Company
H. L. Hendricks, International Lubricant Corp.
Gus Kaufman, The Texas Company
L. W. McLennan, Union Oil Company of California
R. G. Moyer, The Pure Oil Company
H. A. Murphy, Gray Company, Inc.
D. C. Peterson, Stewart-Warner Corporation
L. C. Rotter, Linco'n Engineering Company
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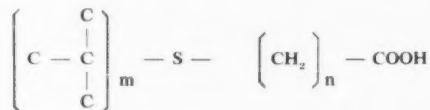
New York 38, N. Y.

Patents and Developments

Complex Soap Grease Containing Thioether Acid Salt

The use of small amounts of soaps of branched chain thioether acids along with the low molecular weight salts and the conventional fatty acid metal soaps is advocated in U. S. patent 2,612,472 issued to Standard Oil Development Company.

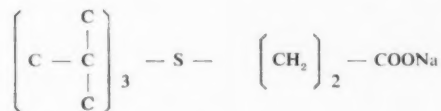
Greases thickened with conventional soaps such as those of long chain saturated fatty acids of 12-24 carbon atoms and a smaller quantity of acetate, propionate, acrylate or methacrylate salt are said to have fairly good properties but, according to the above patent, a superior texture and better softness and stability may be secured by combining 2-6% by weight of a high molecular weight branched aliphatic chain sulfur-bearing soap of an acid having the general formula:



Where m and n are of such value that the total number of carbon atoms is between 10 and 20. The sulfur may be positioned at various points on the chain, but the composition preferably has at least two tertiary carbon atom groups and may have several branched groups of this character.

Compounds of the above type may be prepared by converting diisobutylene, for example, to mercaptan, and reacting with acrylonitrile or equivalent acidic material, followed by neutralization with sodium hydroxide or other appropriate strong base. Oxo alcohols also can serve as a raw material for such compounds.

One composition, prepared in accordance with the patent, contains, in addition to conventional fatty acid soap and fural Cannizzaro reaction product, a sulfur-bearing high molecular weight acid salt having the formula:



Which, in spite of the fact that it is formed from a C_{15} acid, has very little grease thickening action by itself.

Complex Soap Greases Containing Ether Salt

Greases of the type mentioned above also may be made with ether acid salts instead of the sulfur compounds. According to U. S. Patent 2,612,473 issued to Standard Oil Development Company, such ether salts may be produced

from a mixed C_{12} OXO alcohol prepared by conventional catalytic oxonation of C_{12} polymers of low molecular weight α -olefins with carbon monoxide and hydrogen. Equimolar amounts of the alcohol and beta chloropropionic acid were reacted to form an acid having the general formula $\text{C}_{13}\text{H}_{27}\text{O}(\text{CH}_2)_2\text{COOH}$.

A composition containing:

- 15.0% $\text{C}_{13}\text{H}_{27}\text{O}(\text{CH}_2)_2\text{COOH}$
- 6.0% furoic acid
- 5.2% NaOH
- 1.0% phenyl alpha naphthylamine
- 72.8% mineral lubricating oil (55 vis. at 210°F .)

produced a grease containing excellent, smooth, short fibers having a dropping point of over 500°F ., and 500 hrs. stability measured by Norma Hoffman oxidation resistance.

Synthetic Greases from Resin Base Dispersion Products

A series of new compositions is described in U. S. patent 2,612,474 issued to Cities Service Research & Development Company, which may be prepared by the thermal reaction of a thermosetting plastic such as partially polymerized phenol-formaldehyde resin and one or more oily-like synthetic liquids, such as tri- α -cresyl phosphate, tri octyl phosphate, tributyl phosphate, dibutyl phthalate, etc. By adjusting the proportions of resin employed between 2-20%, it is possible to vary the consistency of the product between that of a thin, highly fluid oil to a thick gel having the consistency of a hard, stiff cup grease.

In the reaction, it appears that the phenol-formaldehyde reaches a stage of complete polymerization, and that the resulting product is a colloidal dispersion of fully polymerized resin in the liquid, rather than a true chemical composition of two materials. The new compositions are not subject to oxidation or other chemical change which would vary their consistencies and other properties, and they appear to have little or no reaction upon copper, steel, aluminum, etc. Also, they resist dissolution in ordinary solvents. Even the softest gels appear to be insoluble in boiling water, hot gasoline, kerosene, and most other solvents. The gels are claimed to have been subjected to temperatures of the order of 600°F . for short periods without loss of lubricating value other than that resulting from the evaporation of liquid.

An example of such a grease is a composition containing 11% by weight of phenol-formaldehyde resin and 89% trioctyl phosphate. The product was prepared by dissolving 8 grams of an acetone solution containing 80% of a phenol-formaldehyde resin which had not been carried beyond the first stage of polymerization, and which contained an excess of formaldehyde, in some 50 grams of trioctyl phosphate, and heating the mixture to an ultimate temperature of 450°F . At that temperature, the transparent amber liquid is transformed instantly into an opaque thick, stiff gel.

Copper Corrosion-Inhibited Lithium Base Grease

While lithium base greases have proved satisfactory in service, the increased use of copper and copper alloys in certain applications (such as in airplane controls) has introduced an additional problem in rendering the grease non-corrosive to this metal in long-time service. In the Texas Company U. S. patent 2,610,946, a lithium base grease is claimed which meets the copper corrosion test of U. S. Army Spec. 2-134.

This has been made possible by incorporating in the lithium grease about 0.25-3% by weight of an oil-soluble basic alkaline earth metal salt of a sulfonated hydrocarbon, wherein the weight ratio of alkaline earth metal to sulfur content is from 1.1 to 2 times that represented by the normal salt $M(SO_3R)_2$, where M is the alkaline earth metal and R is the hydrocarbon residue. This salt is to be distinguished from

the previously used normal alkaline earth metal sulfonates, such as calcium mahogany sulfonates which are claimed to be completely ineffective for this purpose.

The sulfonates effective in inhibiting copper corrosion are known compounds which have been suggested for use, along with normal mahogany sulfonates, as detergent additives for motor oils. They may be made by sulfonating lubricating oils or other mineral hydrocarbon oils with concentrated sulfuric acid at 150°-180° F., producing substantial sulfonation without excessive loss to acid sludge. The sulfonated oil may be reacted directly with powdered hydrated alkaline earth metal oxide in excess required for neutralization, although it preferably is made by first neutralizing the oil with caustic, extracting with isopropyl alcohol, and precipitating out the sulfonic acids by acidification with sulfuric acid and reacting the acid with lime, barium hydroxide, etc. Santolube 203A is stated to be a lubricating oil concentrate containing about 50% by weight of a basic barium derivative of a sulfonated hydrocarbon, which is satisfactory for this purpose.

Try This Test for Your Tax I. Q.

The American Institute of Accountants Sent These
(We couldn't answer them either.)

Come the Ides of March—comes also federal income tax time. Do you know your federal taxes—what they can do to you—what you can do to them? Try this three-minute tax quiz. (Editor's note: three minutes if you're an expert.) It is based on material furnished by the American Institute of Accountants, the national professional society of certified public accountants. Answers are on page 34.

1. Your son worked for you in the business last summer, and you paid him a total of \$591. He also won \$10 in an advertising slogan contest. You can—

- Take a full \$600 dependency exemption for him.
- Take a half exemption.
- Take no exemption.

2. While on vacation with your wife last summer, you entertained several men you do business with. Is this—

- Deductible as a business expense?
- Not deductible, since you were vacationing?
- Deductible only if you and your wife file a joint return?

3. You made a non-business loan of \$2,000 to a friend last March, and he promptly disappeared, leaving absolutely no trace. You can probably—

- Deduct the full amount as a bad debt on your 1952 return.
 - Deduct only half of it.
 - Take no deduction at all.
4. You earned more than \$3,600 in your business. The social security tax is—

- Not levied on your own income.
- \$81, paid with your income tax return.
- \$54, paid to the Social Security Board.
- \$54, paid with your income tax return.

5. Which of the following contributions is not deductible?

- Your local Community Chest.
- The American Legion.
- A political party.
- The YMCA.

6. You failed to take all your allowable deductions on your 1950 return. You can—

- No longer file a claim for a refund.
- File a refund claim as late as 1954.
- Stop worrying, since you will get a refund automatically.

7. Your wife works for you in your business. She—

- Is required to pay social security.
- Is not subject to social security.
- Can choose whether or not she wants social security coverage.

8. In December, you spent \$1,000 for built-in bookshelves and wall-to-wall carpeting for your office, on which your lease has three years to run. You can—

- Deduct the \$1,000 on your 1952 return.
- Amortize the cost over the next three years.
- Depreciate it over the life of the furnishings.

9. There are a few leaks in the shingle roof of your office building, so you construct a new tile roof. Taxwise, the cost is—

- Deductible as a repair.
- Deductible in the current year as an improvement.
- Depreciable — a portion deductible each year of its useful life.

10. In determining your taxable income, which of the following taxes you pay is *not* allowed as a deduction?

- Real Estate tax.
- State income tax.
- State inheritance tax.
- Motor vehicle license fee.



The user cannot see it by looking in the container, but when he finds a lubricant doing an outstanding job, it's 2 to 1 a Metasap Aluminum Stearate Base is incorporated therein.

For Metasap Aluminum Stearates are today's *foremost* development in grease making. Lubricants made with them are moisture-proof, temperature-resistant, water-repellent... clear and uniform... able to perform superlatively under the toughest conditions.

Whatever your grease requirements, call upon Metasap - and profit by being able to meet every specification with the best possible grease for the job.



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Stocks at Cleveland and Akron, Ohio; Los Angeles and San Francisco, Calif.; Louisville, Kentucky

Stearates
of Calcium • Aluminum • Lead • Magnesium • Zinc



ISOMETRIC SKETCH of the May 14-23 oil show plant shows two new areas, upper right and foreground, which have been added to accommodate demands for exhibit space. All covered or indoor space has been reserved. Only 20,000 square feet of outside space in the new north area remains for exhibitors. Five permanent exposition buildings and more than 40 permanent exhibitors' structures will be used for the show this spring.

30th Anniversary International Petroleum Exposition

From May 14-23, Tulsa, Oklahoma, will be headquarters for an estimated 20,000 oilmen from all over the world.

Oil men from throughout the United States and distant points of the globe—an estimated 20,000 of them—will make Tulsa, Oklahoma, their headquarters during the 30th Anniversary International Petroleum Exposition there next May 14-23.

The big oil show, called the "World's Fair of the Petroleum Industry," is a long-awaited event in all divisions of the industry. It has been on the planning boards since early 1952, with thousands of oil men in every phase of the industry participating on numerous committees and advisory groups.

Large Industry Show

The exposition—last held in 1948—is recognized as the world's foremost industrial show devoted exclusively to a single industry. It is operated by and for all segments of the industry. Though primarily educational, it is the showcase of what is new, and what will be new, in

the many operations of the international oil industry.

Exhibits at the 1953 show will present the multitude of new methods and improvements in every oil activity from exploration to refining, with emphasis on those developed in the last five years. A record 1,500 exhibits, valued at more than \$100,000,000, will be displayed in the 35-acre exposition plant.

Exhibit Space on Waiting List

New strides in mechanical, engineering, research and service techniques have been so great since 1948, say exposition officials, that exhibit space has been on a "waiting list" basis since plans for the show were announced a year ago.

Two large new exhibit areas have been

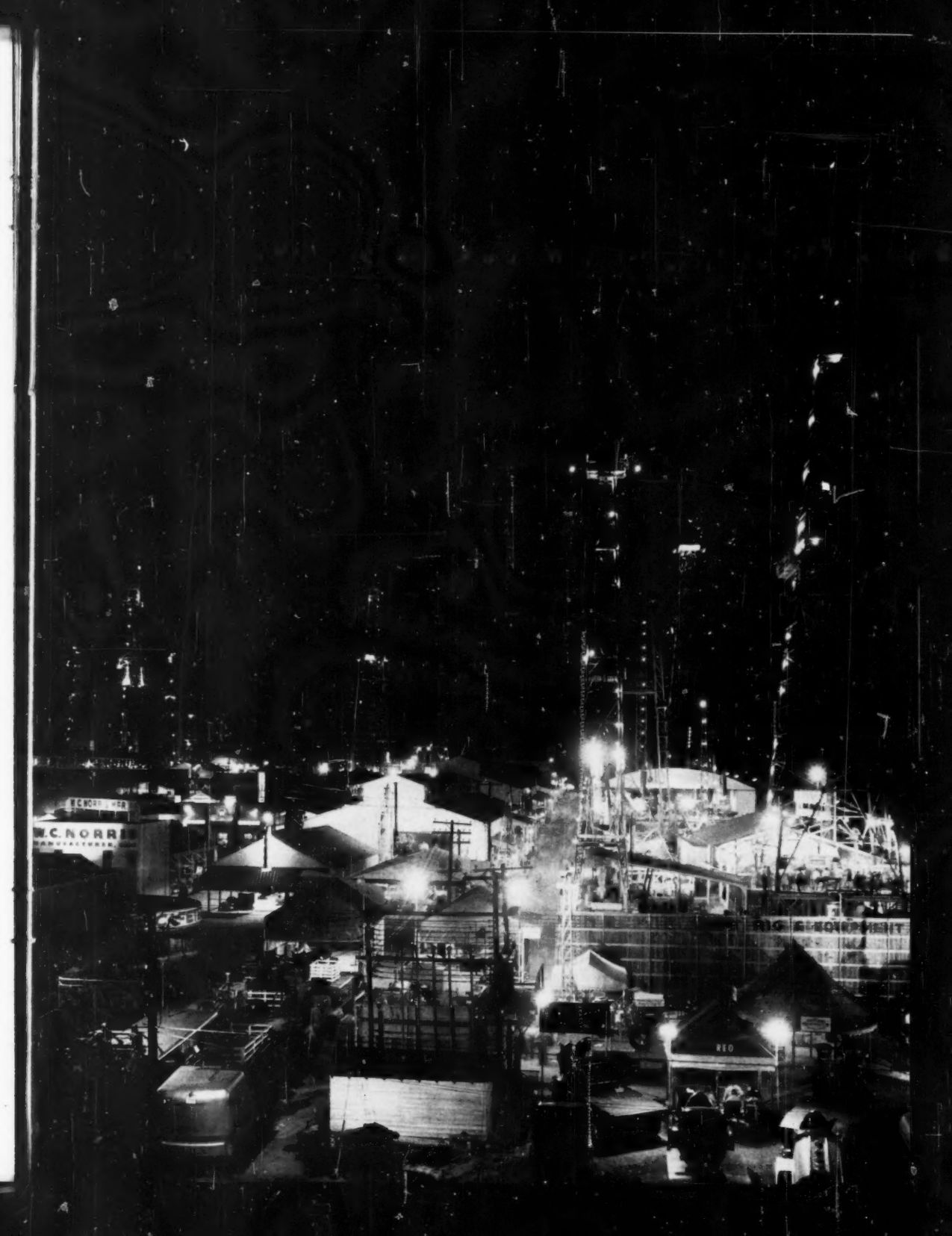
added to the plant which accommodated the last oil show. One of these included 100 new covered booths. However, all covered exhibit areas have been filled and no inside space is now available.

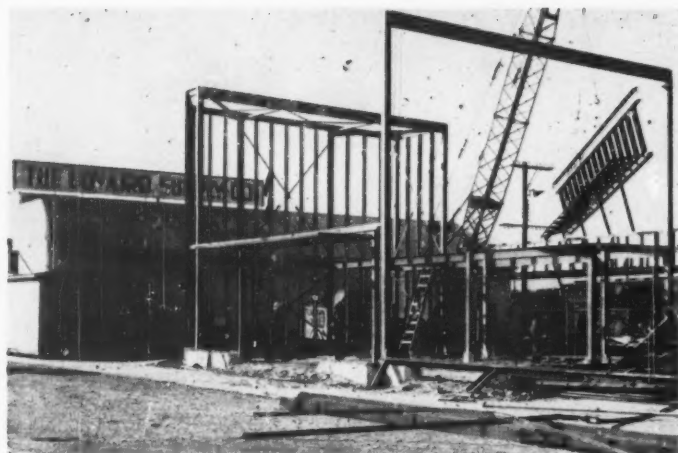
Permanent Facilities Built

In addition to more than 800 booths in five large buildings owned by the exposition, an increasing number of exhibitors are building permanent facilities on the grounds. Some 40 private firms now have their own exhibit buildings, with single investments running as high as \$50,000. Many are remodeling to accommodate larger equipment for the 1953 show.

(Continued on page 30)

NIGHT VIEW of part of the 1948 International Petroleum Exposition gives some idea of the multitude of exhibits, covering every phase of the industry. At the 1953 show in Tulsa, 1500 displays are estimated to be worth \$100,000,000.





The only exhibit space facilities now available are outside space suitable for heavy equipment not needing covered protection. To accommodate outside exhibits, some 20,000 square feet of space—equipped with all utilities—has been fenced into the show grounds.

Record Attendance Expected

In announcing the "sell out" of indoor space, Exposition Manager Wm. B. Way commented that all previous oil show records have already been broken, "except in attendance." However, based on reports from hundreds of exposition "ambassadors," and attendance committees, he predicted a 25 per cent increase over the record 1948 attendance of 300,000, which included 15,000 oil men.

He estimated the oil show will draw attendance from 50 foreign countries, and said "there will be more individuals from each country than ever before." The last exposition was visited by oil men and oil-conscious government officials of 43 nations.

Cooperating in the task of generating interest and attendance from abroad are the NOMADS organization, composed of oil equipment manufacturers and suppliers, the U. S. Department of State, the Department of Commerce, and a host of individual "ambassadors" appointed by Exposition President W. G. Skelly.

Governor Murray Is Chief Ambassador

"Chief ambassador" is Oklahoma's Spanish-speaking governor, Johnston

Murray, who has toured 17 Latin American countries in behalf of the exposition. Governor Murray personally extended invitations to more than 600 oil men and government officials of Central and South America.

Continuous bulletins on the exposition are being sent to foreign governments and U. S. consulates abroad through official channels of the departments of state and commerce.

NOMADS Build Attendance

Organizing the industry's efforts to build international attendance is the NOMADS organization. Harry E. Estes, Houston, Tex., executive secretary of the NOMADS national board of regents, has appointed an international attendance committee composed of members of NOMADS chapters in New York, Los Angeles, Tulsa, Houston and Dallas.

Thousands of oil men throughout the United States, and in other countries of the free world, will serve on committees already formed, and soon to be appointed, to arrange and conduct special events and other activities during the exposition.

One of the outstanding features of the exposition will be a greatly expanded "Hall of Science," which will contain displays portraying the history of development of the oil industry, and explaining the latest technical advancements in the myriad phases of the industry.

CREWS WORKING on remodeling and redecorating exhibitors' buildings are feverishly applying their skills so preparations will be complete by opening day, May 14. Recently one of the larger exhibitors, National Supply Co., razed the building which had housed previous exhibits in order to make room for a more suitable structure. In the photo, only the skeletal framework remains, and one large section of that is being lowered to the ground. The Bovaird Supply Co., exhibit building is visible in the background.

A traditional educational adjunct of the oil show, the Hall of Science is recognized as the world's foremost museum of science and industry devoted solely to petroleum and its products.

Committee Searches for Exhibits

A scientific and technical committee, which has charge of the hall, is conducting a worldwide search for appropriate exhibits. No charge is made for exhibits in the hall. They will be contributed by oil companies, service firms, research organizations, and other institutions which have devised scale models and animated displays of equipment, processes and methods developed purely as oil industry innovations.

Some of the world's outstanding petroleum scientists will serve on the scientific and technical committee. Its chairman is G. H. Westby, president of Seismograph Service Corp., an oil exploration firm operating worldwide. Special consultants include Dr. Gustav Eglhoff, Universal Oil Products, Chicago; Dr. B. B. Weatherby, internationally known geophysicist of Amerada Petroleum Corp., and A. E. Ballin, president, Balco Engineering Co., Tulsa.

One of the busiest groups now at work on the oil show is the housing committee. With thousands of visitors to accommodate, adequate special housing must be arranged months in advance. More than 1,150 private Tulsa homes have been listed with the IPE housing bureau for use by visitors to the oil show.



A good rule to follow for better greases...

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WITCO stearates are especially noted for a high degree of uniformity, freedom from foreign matter, low moisture and low soluble salt content. They produce medium to extremely high gels of excellent stability, smoothness and color, and their superior gelling characteristics tend to make them more economical.

Witco manufactures a complete line of grease-grade stearates, each designed to do a specific job:

WITCO Aluminum Stearate No. 22...medium gel strength. Suitable wherever a definite percentage of soap is required.

WITCO Aluminum Stearate No. 22-H...medium-high gel. Excellent economy and performance. Produces smooth, stable greases. Particularly recommended for Gulf Coastal and low viscosity index stocks.

WITCO Aluminum Stearate No. 23...medium-high gel. Excellent economy. All around good performance in a variety of oil stocks.

WITCO Aluminum Stearate No. 22-C...very high gel. Outstanding performance in Pennsylvania base and high viscosity index stocks.

WITCO Aluminum Stearate No. 22-G...extremely high gel. Produces greases of excellent stability with minimum tendency to bleed. Excellent color and clarity.

WITCO Lithium Stearate...forms clear, light-colored greases with excellent water resistance. Operating temperatures from -90°F to 400°F . 6% to 8% soap ample for multipurpose greases.

WITCO Lithium Hydroxystearate...good water resistance and high stability over a wide temperature range. Excellent non-corrosive properties. Well suited for synthetic greases.

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PEOPLE in the Industry

Battenfeld Announces Appointments of Sales Managers



WILSON SIMMONS

Two promotions in the sales department of the Battenfeld Grease & Oil Corporation have been announced: Wilson Simmons, as sales manager, lubricating grease division; Robin S. Nowell, as sales manager, waterproofing division.

These men have been with the company several years with experience in the firm's production and technical departments. For the last few years Mr. Simmons has been Eastern sales representative and Mr. Nowell, Southern sales representative.



R. S. NOWELL

Earl R. Fiene Promoted By Alemite Division, Stewart-Warner Corporation

Earl R. Fiene has been appointed manager of the Detroit wholesale sales branch of the Alemite and Instrument division of Stewart-Warner Corporation, F. A. Hiter, senior vice-president of the corporation and head of the division, has announced. The Detroit branch handles sales of lubricating equipment, speedometers and other component or accessory products to car and truck manufacturers and to other original equipment customers.

Mr. Fiene, a 16-year employee of Stewart-Warner, succeeds H. J. Howerth, whose assistant he has been since March 1951. Mr. Howerth, since 1935 assigned to car factory service promotion and sales responsibilities, has joined the distribution sales division at the corporation's general offices, Chicago.

Magie Brothers Chooses Wm. C. Bryant As New Research Director in Charge Of Certain Products

Wm. C. Bryant was made research director for Magie Brothers in September. He has charge of all products development on lubricating greases, process oils, cutting oils and core oils.

At present Mr. Bryant is dividing his time between Magie Brothers' Chicago and Franklin Park plants. It is intended to consolidate facilities in one new laboratory at Franklin Park this spring.

Mr. Bryant has been active through the years in technical committee work with N L G I, ASLE, ASTM, SAE, AATCC, AIP (Rheology). He is a member of the American Institute of Physics and the company's representative on the technical committee of N L G I.

J. G. Campbell Promoted By Deep Rock Oil Corp.

John G. Campbell has been named general sales manager for Deep Rock Oil Corp., according to W. J. Carthaus, vice-president, manufacturing and distribution.

Mr. Campbell, head of Deep Rock's supplies and economics division since joining the company in 1948, will assume his new post immediately.

In his new role, Mr. Campbell will supervise and co-ordinate functions of Deep Rock's jobber sales, merchandising, sales control, and supplies and transportation departments.

Mr. Campbell's new position will place him in charge of all Deep Rock marketing operations except those presently assigned to William M. Murray, who continues as general products sales manager, and whose duties and responsibilities remain unchanged.

Before joining Deep Rock, Mr. Campbell was associated for seven years with a major oil company in transportation and supplies and economics work.

A native of Maryland, Mr. Campbell was graduated from Amherst College in 1930 and did graduate work at New York University. He saw active duty as a lieutenant in the Naval Reserve in the Asiatic-Pacific theatre in World War II.



WM. C. BRYANT

THE INSTITUTE SPOKESMAN

Industry NEWS

Midwest Holds Symposium On Automatic Computers In January at Kansas City

Automatic computers are fostering a new concept in engineering thought, Rex Rice, Northrop Aircraft, Inc., Hawthorne, Calif., told some 200 technical and management personnel who attended the two-day symposium on automatic computing equipment sponsored by Midwest Research Institute in Kansas City January 8 and 9. Speaking during a panel discussion at the meeting, Mr. Rice stressed this new trend as one of the major gains from the use of automatic computing equipment.

A major U. S. airline presented a problem to the meeting involving application of computer principles. This particular project calls for consolidation, recording and distribution of such varied information as crew flight time, traffic loads, mechanical performance, costs, arrivals and departures, etc. It was

pointed out that this task is within the scope of existing machines, but that the crux of the problem lies in development of satisfactory methods for programming this information for the computers.

Booklet on Additives Describes Developments

The Petroleum Educational Institute announces the publication of a pocket-size booklet entitled ADDITIVES, which describes new and late developments in the field of additives used in industrial and automotive oils and greases.

It offers an elementary explanation of

1. The problems which are solved or relieved by use of present day additives.
2. The action of present day additives which attacks the problem to be solved.
3. How the action of present day additives serves to attack the problem.
4. The several test engines used to evaluate the merits of present day additives.
5. Procedure of the "L" series and

other tests used to evaluate additive type oils.

6. The API Service Classification and Designations for automotive-type engine oils.

The booklet, which is paper bound, has 80 pages and 110 illustrations. The cost is \$1.50 postpaid and can be purchased from the Petroleum Educational Institute, 9020 Melrose Avenue, Los Angeles 46.

Witco Moves Main Office

To better handle the expanded operations of its main office in New York, Witco Chemical Company has moved to larger and more modern headquarters in the new building at 260 Madison Avenue, New York 16, New York. The telephone number, MUrray Hill 5-6020, will remain the same.

This is Witco's first move since 1935 and the second in the company's 33-year history.



A Complete Line of Quality Oils and Greases



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Steel Pails and Drums

FOR OILS, GREASES, ETC.



No. 9 Niles Pail
with lug cover
and pour spout.

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ordinarily are supplied with bail handles. Fabricated from black steel—outside painted or lithographed to order. Removable tops with lug covers, with or without pour spouts. Also in tight head style. $3\frac{1}{2}$ to 6 gallon capacities.

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NILES STEEL DRUMS

55, 30 and 15 gallon capacities; and 100-lb. or 120-lb. grease drums. Full open head or Bung type. Painted or fully decorated. Interior lacquered if desired.



100-lb. or 120-lb. Niles Grease Drum with 14 inch full open top lug cover. Also made with 9 inch lug cover in center of head.



Write for literature and quotations

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REPUBLIC STEEL CORPORATION
465 Walnut Street • Niles, Ohio

YOUR TAX I.Q.

Answers to quiz on page 26

1. c. Your son's prize here would be considered taxable income. That raises his total income to \$601, and he cannot qualify as a dependent if he has income of \$600 or more.
2. a. The amounts spent should be deductible as business expenses, if you kept a careful record which lists them in detail, and shows clearly that the entertainment was with a predominating business motive and not merely reciprocal, or incident to the vacation.
3. b. A non-business bad debt is a capital loss. And you can take only \$1,000 a year in capital losses—unless you can apply them against capital gains. You are allowed to carry over unused losses for five years; better get expert advice.
4. b. Assuming your income is classified as self-employment income (see tax instructions) and is not from engaging in an exempt profession, a tax of $2\frac{1}{4}\%$ on the first \$3,600 is due with your income tax return — so you owe \$81.
5. c. You cannot deduct contributions to an organization which spends a substantial part of its time on lobbying or political propaganda.
6. b. In this case, you can file a claim for refund within three years from the date your return was due.
7. b. If your wife works for you, you are not supposed to pay social security taxes on her salary, nor is she supposed to make her contributions.
8. b. On leased property, you normally spread the cost of improvements over the life of the lease.
9. c. The roof is an improvement, not deductible currently like ordinary repairs. Its cost is deductible as depreciation spread over its estimated useful life.
10. c. Inheritance taxes are not deductible. The others listed are deductible.

Deep Rock Oil Expands Blending, Packaging Plant

Deep Rock Oil Corporation has expanded its blending and packaging plant at Cushing, Okla., as the first step in a multi-million dollar modernization program planned for its lubricating oil manufacturing facilities.

Newest installations provide for improved packaging and materials handling facilities, a complete drum reconditioning line, greater warehouse and outloading capacity, and increased blending capacity.

In designing and constructing the plant, the chemical plants division of Blaw-Knox Construction Company utilized previously existing structures at the Deep Rock plant.

Existing buildings were reconditioned and a new 45-foot by 135-foot warehouse building was added. Base stock storage capacity was increased. A new power substation was installed. The plant's railroad spur was extended and a new loading dock was added.

Construction did not interrupt operations or reduce production.

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FUTURE MEETINGS of The Industry

FEBRUARY, 1953

- 16-18 American Petroleum Institute (Division of Marketing, Lubrication Committee meeting), Sheraton-Cadillac, Detroit, Mich.
- 18-19 Iowa Independent Oil Jobbers Assn. (annual convention), The Savery, Des Moines, Ia.
- 25-26 Wisconsin Petroleum Association, Hotel Schroeder, Milwaukee, Wisc.
- 26 to Pacific Automotive Show, Civic Mar. 1 Auditorium, San Francisco, Calif.

MARCH, 1953

- 2-6 American Socy. for Testing Materials (spring meeting), Hotel Statler, Detroit, Mich.
- 3-5 Socy. of Automotive Engineers, National Passenger Car, Body, and Materials Meeting, Sheraton-Cadillac, Detroit, Mich.
- 4-6 American Petroleum Institute (Division of Production, Southwestern District spring meeting), Hilton Hotel, Ft. Worth, Tex.
- 8-11 American Inst. of Chemical Engineers, The Buena Vista, Biloxi, Miss.
- 9-11 Mfrs. Standardization Socy. of Valve and Fittings Industry, Hotel Commodore, New York, N. Y.
- 10-12 Illinois Petroleum Marketers Assn. (annual convention), Hotel Sherman, Chicago, Ill.
- 15-19 American Chemical Society (123rd national meeting), Hotels Biltmore and Statler, Los Angeles, Calif.
- 15-19 American Institute of Mining and Metallurgical Engineers (annual joint meeting of petroleum metals, and mining branches), Statler Hotel, Los Angeles, Calif.

- 16-20 National Assn. of Corrosion Engineers (1953 conference and exhibition), Hotel Sherman, Chicago, Ill.
- 17-19 Ohio Petroleum Marketers Assn. (annual convention and exposition), Deshler-Wallick, Columbus, Ohio.

- 24-27 Greater New York Safety Council (23rd annual safety convention and exposition), Hotel Statler, New York, N. Y.

- 25-27 Socy. of Automotive Engineers (national production meeting), Hotel Statler, Cleveland, Ohio.

- 28 North Texas Oil & Gas Assn. (annual meeting), Kemp Hotel, Wichita Falls, Tex.

- 30-31 Texas Independent Producers & Royalty Owners Assn. (7th annual meeting), Gunter Hotel, San Antonio, Tex.

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"I CAN ALWAYS GET
THE CAR IF I TELL
POP I'LL HAVE IT
LUBRICATED!"

- 18-20 American Petroleum Institute (Division of Production, Mid-Continent District spring meeting), Mayo Hotel, Tulsa, Okla.
- 19-21 Texas Oil Jobbers Assn. Inc. (annual convention), The Plaza Hotel, San Antonio, Tex.
- 23-25 Western Petroleum Refiners Assn. (annual meeting), Plaza Hotel, San Antonio, Tex.
- 23-26 American Assn. of Petroleum Geologists—Socy. of Economics Paleontologists and Mineralogists—Socy. of Exploration Geophysicists (joint annual meeting), Coliseum, Houston, Tex.

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makers of
Gargoyle Industrial Oils and Greases

FUTURE MEETINGS of The Industry

APRIL, 1953

8-10 American Petroleum Institute (Division of Production, Eastern District spring meeting), Hotel William Penn, Pittsburgh, Pa.

13-15 American Socy. of Lubrication Engineers (annual meeting and exhibit), Hotel Statler, Boston, Mass.

13-15 Assn. of Nebraska Liquefied Petroleum Gas Dealers (annual convention), Hotel Fontenelle, Omaha, Neb.

15-17 National Petroleum Association (semi-annual meeting), Hotel Cleveland, Cleveland, Ohio.

16-19 National Tank Truck Carriers Inc., Boca Raton Hotel, Boca Raton, Fla.

20-22 American Petroleum Institute (Division of Transportation, products pipeline conference), Hotel Muehlebach, Kansas City, Mo.

26-29 American Inst. of Chemical Engineers (joint meeting with Chemical Institute of Canada), Royal York Hotel, Toronto, Canada.

27-28 Independent Petroleum Assn. of America (midyear meeting), Jefferson Hotel, St. Louis, Mo.

MAY, 1953

4-5 American Petroleum Institute (Division of Marketing, midyear meeting), Baker Hotel, Dallas, Tex.

4-6 Liquefied Petroleum Gas. Assn. (annual convention & trade show), Conrad Hilton Hotel, Chicago, Ill.

7-8 American Petroleum Institute (Division of Production, Rocky Mountain District spring meeting), Gladstone Hotel, Casper, Wyo.

10-12 Pennsylvania Petroleum Assn., Inc. (3-day meeting), Bedford Springs Hotel, Bedford Springs, Pa.

11-13 American Petroleum Institute (Division of Marketing, Lubrication Committee meeting), Greenbrier, White Sulphur Springs, West Va.

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.. LEATHER TANNING

Used in water emulsion as a needle oil on nylon knitting machines in

..... TEXTILES

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..... PAINT

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If you have a corrosion problem with light petroleum products in storage or transit, investigate Santolene C. For information, write, wire or phone MONSANTO CHEMICAL COMPANY, Organic Chemicals Division, 800 North Twelfth Blvd., St. Louis 1, Missouri.

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Representative—John H. Strome

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917 Roanoke Ave. S. E.
Warren, Ohio
Representative—Lawrence F. McKay

Rheem Manufacturing Company
570 Lexington Avenue
New York 22, New York
Representative—F. J. Blume

Riese Metal Products Corporation
Auburn, Indiana
Representative—Ralph S. Pearson

United States Steel Products
Division United States Steel Company
30 Rockefeller Plaza
New York City 20, New York
Representative—Wm. I. Hanrahan

Vulcan Stamping & Manufacturing Co.
P. O. Box 367
Bellwood, Illinois
Representative—H. B. Scharbach

MANUFACTURERS OF EQUIPMENT FOR APPLICATION OF LUBRICATING GREASES

Ara Equipment Corporation
Bryan, Ohio
Representative—R. W. Morrison

Balcrank, Inc.
Disney near Marburg
Cincinnati 9, Ohio
Representative—Richard P. Field

Gray Company, Inc.
60 Northeast 11th Avenue
Minneapolis 13, Minnesota
Representative—B. A. Beaver

Lincoln Engineering Company
5701 Natural Bridge Avenue
St. Louis 20, Missouri
Representative—G. A. Hubbard

Stewart-Warner Corporation
Alemit Division
1826 Diversey Parkway
Chicago 14, Illinois
Representative—Walter Duncan

United States Air Compressor Company
5300 Harvard Avenue
Cleveland 5, Ohio
Representative—C. A. Bening

SUPPLIERS OF EQUIPMENT FOR MANUFACTURING LUBRICATING GREASES

Bufflovak Equipment Division of
Blaw-Knox Company
1543 Fillmore Avenue
Buffalo 11, New York
Representative—Edward V. Hegg

Chemicaloid Laboratories, Inc.
30 Church Street
New York 7, New York
Representative—David F. O'Keefe

The Girdler Corporation
224 East Broadway
Louisville 1, Kentucky
Representative—J. E. Slaughter, Jr.

Morehouse Industries
707 Henry Grady Building
Atlanta 3, Georgia
Representative—George E. Missbach

Stratford Engineering Corporation
1414 Dierks Building
Kansas City 6, Missouri
Representative—J. W. Sylvester

MARKETING ORGANIZATIONS

California Texas Oil Company, Limited
551 Fifth Avenue
New York 17, New York
Representative—Hal U. Fisher

REFINERS

Farmers Union Central Exchange, Incorporated
P. O. Box G
St. Paul 1, Minnesota
Representative—H. F. Wagner

Freedom Valvoline Oil Company
Box G
Freedom, Pennsylvania
Representative—D. A. Smith

Mid-Continent Petroleum Corporation
Mid-Continent Building
P. O. Box 381
Tulsa, Oklahoma
Representative—J. W. Basore

TECHNICAL AND RESEARCH ORGANIZATIONS

Midwest Research Institute
4049 Pennsylvania
Kansas City 2, Missouri
Representative—Dr. M. H. Thornton

Petroleum Educational Institute
9020 Melrose Avenue
Los Angeles 46, California
Representative—G. A. Zamboni

Phoenix Chemical Laboratory, Inc.
3953 W. Shakespeare Avenue
Chicago 47, Illinois
Representative—Mrs. G. A. Krawetz

Sociedade Nacional de Petroleos
Rua D. Pedro V, no. 80
Lisbon, Portugal
Representative—Manuel Corda Boullosa



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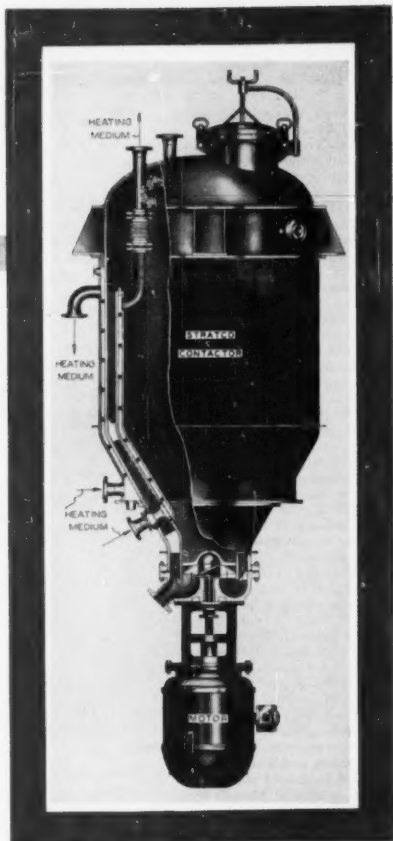


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